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The guavas of the Hawaiian Islands

Vaughan MacCaughey

The guavas comprise a valuable and widely distributed genus (*Psidium* L.) of tropical and subtropical fruit trees and shrubs. They are indigenous to America, but numerous species are now thoroughly established in many of the warmer parts of Africa, Asia, Oceanica, and other regions. There are about 150 known species, and presumably a large number of forms in South and Central America that are still undescribed.

Seven or more species and forms have been established in the Hawaiian Archipelago since early times and now constitute an important element in the lowland flora. The Hawaiian Islands were discovered by the Spanish in 1555, over two hundred years before the discovery by the great English circumnavigator, Captain Cook. Although historical data concerning these two centuries is very scanty, there is little doubt but that the Spaniards visited the islands repeatedly, and accidentally or purposely introduced various Mexican, Central American, and West Indian plants. The common guava in its several forms was introduced either during this period or within a relatively short time after the discovery by Cook. It was spread rapidly from island to island and locality to locality and has now become a dominant woody weed in many lowland, valley, and foothill regions. It possesses all the attributes essential for aggression—great hardihood with reference to untoward conditions; rapid growth; deep roots; ability to thrive on scanty water supply; power of flourishing on rough, rocky ground; production of sturdy root-sprouts in great numbers; prolific and almost continuous fruit production, with vast numbers of viable seeds; resistance to insect and fungus pests; notable powers of dissemination.

The fruits of all the species are attractive to animals, and the seeds of the wild guavas are widely scattered throughout the islands, both on the lowlands and in the mountains, by means of wild and domestic live-stock and birds. The Chinese dove (*Turtur chinensis*), mynah bird (*Acridotheres tristis*), rice bird (*Carpodacus mexicanus obscurus*), sparrow (*Passer domesticus*), Chinese reed-warbler (*Trochalopterum canorum*), and other introduced birds, as well as the steadily decreasing indigenous birds, all feed freely upon the guavas, and disseminate them to the most remote regions. The wild swine, goats, sheep, and cattle also feed upon the fruits, and assist in the distribution of these ubiquitous plants. Numerous insects, especially of the Orthoptera, gnaw holes in the ripening fruit, and devour the pulpy interior.

As a result of their marked adaptability to local conditions the Hawaiian guavas have become serious pests, particularly on the arable lands. The wild guava, together with Hawaii's other chief woody pest, the lantana (*Lantana Camara* L.), occupy thousands of acres, to the practical exclusion of indigenous vegetation. The main guava zone is in the lowland area, including the valleys, ridges, and foothills, up to an elevation of about 300 meters. Isolated trees are not uncommon above this level, but the great tracts of almost unbroken guava "scrub" lie below it. On the islands of Maui and Hawaii, which rise to 3,000 and 4,200 meters, respectively, the upper limit of the guava scrub is usually about 100 meters, but the general proportions of the zones are about the same as on the lower islands.

Land desired for agricultural purposes, that has become overgrown with guava scrub, is very difficult to clear. The roots are so deep, tough, and interwoven that their removal necessitates arduous hand labor; they cannot be plowed up by ordinary methods. Moreover, the roots are so long-lived, even when cut into fragments, and sprout so freely, that every piece must be removed from the soil if the clearing is to be permanent. In hurried or careless clearing of the land, when many roots are left, they quickly send up vegetative shoots and again take possession of the soil. So laborious is the clearing of guava-land that the usual contract price, in the vicinity of Honolulu, is from fifty to one hundred dollars per acre, varying with the density of the scrub and the stoniness of the land.

On side-hills and valley slopes and other waste land that has no agricultural value, the guava, like its close associate the lantana, is a beneficial plant. It improves the soil, both in physical character and in nutritive content; it checks erosion; and gradually ameliorates otherwise barren and unattractive areas. The guava is a successful and valuable pioneer, although difficult to eradicate when the land is needed for other purposes. The great areas of guava scrub that are distinctive of so many of Hawaii's lowland regions have a commercial value as bee-pasture. The flowers are fragrant and highly nectiferous, and yield an excellent grade of honey. The wild guava has high rank among the honey-plants of Hawaii.

In addition to the wild forms of guava, which are so common throughout the lowlands, there are a number of choicer varieties occurring only in cultivation. These are restricted to the larger estates, tropical gardens, and older plantations, where the less common tropical economic plants receive special consideration. The Hillebrand gardens, the Moanalua estate, the Jaeger gardens, Ainhau, and gardens in the older settlements at Waimea, Lahaina, Kohala, and Hilo, are examples of situations where these less generally known forms are to be found.

The genus *Psidium* is myrtaceous, and nearly related to *Myrtus*, *Eugenia*, and *Punica*. The generic name is from the Greek *psidion*, meaning pomegranate, a fanciful reference to the fruit. Guava is from the native Guiana name, *guayaba*. The genus comprises low-growing trees or shrubs, characterized by leaves which are opposite, petiolate, glabrous, pubescent or tomentose, and pinnately veined. The flowers are solitary or few (one to three, rarely many), on axillary or lateral peduncles; they are usually rather large and whitish. The calyx-tube is urceolate or pyriform, adnate at the base; lobes four or five, persistent; upper free portion entire and sometimes closed over the flower in the bud, and later coming off entire or splitting irregularly into two to five lobes. The petals are four or five, free and spreading. The stamens are numerous, disposed in many series and inserted upon the disk; filaments filiform; anthers oblong or linear, basifixed, and longitudinally dehiscent. The ovary has two to seven, commonly four, locules, with many ovules in each locule, inserted on bifid, axile placentas. The style is slender, the stigma peltate or subcapitate. The fruit is a berry, in shape ovoid, globose or pyriform, and about 2.5–7.5 cm. long and crowned with the calyx-limb. The skin is thin and delicate, yellow to red in color, sometimes green. The seeds are few to numerous, small, hard, kidney- or horseshoe-shaped; the embryo curved, with a long radicle and short cotyledons. The guavas are all readily propagated from seed, and often fruit the second year from seed. The fruit of none of the horticultural forms is suitable for shipping, as it is too delicate, and ripens too quickly.*

The Common Yellow Guava

This species, *P. Guajava* L., in its several forms, is the most abundant representative of the genus in the Hawaiian flora. It is also called lemon guava, or wild guayaba although these names are not distinctive. The Spanish name is *guayaba*, and the aboriginal Mexican name, *xalxocotl*. It ranges from Mexico to Central America and Peru. It is highly variable, and has many horticultural forms, which are not thoroughly known. The two varieties that are commonly given in the literature, "*pomiferum*" and "*pyriferum*," referring to the shape of the fruit, are no longer given botanic status, as they represent indefinite variations. In California a variety is known to the trade as "Hawaiian Guava"—it has a yellow skin and pink flesh—but has not been demonstrated to be a genuine variety.

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* Engler & Prantl (Nat. Pflanzenfam 3^7: 67–69), give the following characterization of the genus:

Psidium L. (*Acca* Berg, *Calyptropsidium* Berg, *Mitranthes* Berg z. T.) Blütenachse meist gestreckt, ± über den Frkn. hinaus verlängert. Kelch verwachsenblättrig, beim Aufblühen mit meist bis zum Staminaldiscus reichenden Längrissen in die einzelnen B. oder unregelmässig zerreissend, sehr selten haubenartig abgesprengt. A. oval bis linear, dorsifix. N. knopfig; meist 4–5 (2–7) Frb., die nicht ganz bis zur Achse verwachsen, so dass die Placenten parietal bleiben und in jeder Kammer einen oblongen Kranz bilden.—Alles übrige wie bei *Myrtus;* nur die (meist behaarten) B. und die Bl., überhaupt die ganzen Pfl., durchschnittlich kräftiger.

Their synopsis of the genus, with typical species, is:

Sect. 1. APERTIFLORA Ndz.
    A. OBLONGIFOLIA Ndz.: *P. ciliatum* Benth.; *P. aromaticum* Aubl.
    B. OBVERSIFOLIA Berg.: *P. Cattleyanum* Sabine.
    C. ALBOTOMENTOSA Berg: *P. incanescens* Mart.; *P. grandifolium* Mart.
Sect. 2. CALYPTRATA Ndz.
    A. INTEGRIFOLIA Ndz.: *P. Guayava* Raddi; *P. Araça* Raddi.
    B. CRENATIFOLIA Berg: *P. striatulum* DC.; *P. fluviatile* Rich.
Sect. 3. CALYPTROPSIDIUM Berg: *P. eugenioides* (Comb.) Ndz.

The common guava is an arborescent shrub or small tree, sometimes rising to the height of 9–12 m., but usually only 3–6 m. The trunk is slender, and usually divides close to the ground into a number of sinuous stems. The outer bark exfoliates in large brittle flakes or scales, exposing the beautiful smooth, greenish brown inner bark. The mottled trunk of the guava is very attractive and has distinct ornamental value. The young branches are pubescent and four-angled or winged. The leaves are ovate to oblong-elliptic, 8–15 cm. × 5–7 cm.; apex usually acuminate, base rounded; light green, chartaceous, glabrous above, soft pubescent beneath. The principal veins are very prominent, impressed above and raised below. The petiole is short, 5–7 cm. in length.

The flowers occur on the branches of recent growth; they are white, fragrant, and in clusters of one to three on axillary peduncles 1–2.5 cm. long. The pedicels are about 1.5 cm. long, and bear two small, slender bracts at the upper end. The calyx-tube is oblong-ovate, slightly constricted above the ovary. The calyx is closed before anthesis, splitting into two to four irregular segments, whitish and sparsely hairy within. The petals are broadly oval, about 1.5 × 1 cm., thin, delicate, and white. The stamens are erect or spreading, in a broad cluster; filaments 1 cm. long, anthers pale yellow. An abundance of nectar is produced.

The fruit is globose, ovoid or pyriform. It is 7–10 cm. long, and weighs 140–225 g. The rind is somewhat rough, and changes in color from dark green to brownish yellow and finally to clear, deep yellow. The flesh is whitish, yellowish, or dark pink, usually the latter, and comprises two regions—an outer layer, just beneath the rind, which is firm and finely granular; and a more extensive inner mass, of soft, juicy material. The flavor is sweet or somewhat acid; the distinctive feature is the pronounced musky aroma, which is very penetrating. This aroma, which is highly developed in fully mature fruit of good quality, is very agreeable to some people and quite unpleasant to others. The seeds are numerous, reniform or flattened.

The common guava is the chief source of the guava jelly of commerce. Large quantities of guava jelly and jam are manufactured locally, by the orientals, Portuguese, and others. Every little wayside Chinese shop carries a stock of guava jelly. An excellent grade of jelly is made by the American preserving firms for local use and for export to the mainland. However, the manufacture of guava jelly is not as important an industry in Hawaii as it is in many other tropical countries, such as the West Indies, South America, and India. "Goiabada" is made and sold in large quantities in Brazil; it is a thick guava jam. A similar stiff paste is sold in the West Indies and Florida as "guava cheese." Guavas are offered for sale in the various local island markets, and in Honolulu are peddled from door to door by the Portuguese children, who gather the wild fruit. The wide range of guavas in the dietary of white people living in the tropics is well indicated by reference to standard Honolulu cookbooks,* where many recipes are given.

In the Hawaiian Islands the guava is so common as a weed of the roadsides and wastelands that little attention is given to its culture. Dependence is placed upon the abundant supply of wild fruit, rather than upon planted trees. In India, the West Indies, and other countries where this species is not so abundant, the trees are easily raised from seed. The seedlings are transplanted when two or three years old, and bear fruit one or two years after planting. Occasionally a plant will bear fruit the second year from seed, but this is unusual. The prolific production of root-sprouts has been mentioned; this habit affords a very easy method of propagating the plant.

The guava is used in parts of India for dyeing. By boiling the leaves and bark with certain other plants, a black color is obtained, and used for dyeing yarn or cloth. The leaves, either alone or with mango leaves, are used by the poorer classes for tanning. Astringency is a characteristic property of the plant, and the roots, leaves and fruits are utilized medicinally for diarrhoea, scurvy, and similar ailments. The leaves are commonly used in India in the preparation of poultices.

Guava wood is whitish or pale yellowish, moderately hard, even- and close-grained, and weighs about 42 lbs. to the cubic foot. It works easily and smoothly, and takes a beautiful polish. In some countries it is used for tools, spear handles, etc., but has no special uses of this kind in Hawaii. Here it is of much importance as a source of charcoal, and is cut and prepared by the orientals for this purpose. In excursions across country through the guava scrub, one commonly passes the little huts and furnaces of the charcoal burners and finds the men and women themselves, laboriously cutting the saplings, reducing them to proper length, and tending the adobe furnaces.

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* See, for example, Turner, Jessie C., & Alexander, Agnes B. How to use Hawaiian fruits, 30–34. Honolulu. 1910.

The Mediterranean fruit-fly (*Ceratitis capitata*), which before the introduction of its insect parasites* seriously infested a great variety of both native and introduced fruits in Hawaii, was exceedingly plentiful in the guavas. It attacked all of the local forms, but was particularly abundant in the strawberry guava and the wai-awi guava. For a number of years, until the introduced parasites became effective in their control work, there were comparatively few uninfested guavas in the region of Honolulu and its adjacent valleys. An estimate, based upon the examination of thousands of fruits in the field during this period, would indicate that eighty per cent. of the guavas at any given time were infested by the fruit-fly. During the past two years, 1915–16, the infestation has not been so serious, owing to a gradual readjustment of the pest to control factors.

The common white mealy bug (*Pseudococcus nipae*), which infests the grape, fig, avocado, annonas, etc., and several species of aphids are very common on the guava foliage. Their favorite habitats are along the prominent veins, on both surfaces of the leaves. They are most abundant on the older leaves, as the very young leaves are quite tomentose. The cottony guava scale (*Pulvinaria psidii*), and the pepper-tree scale (*Aspidiotus lantaniae*) are also plentiful on both wild and cultivated guavas. Fuller's rose beetle (*Aramigus fulleri*) feeds to a great extent on guavas on the islands of Molokai and Hawaii. A bark beetle (*Xyleborus affinis*) is recorded as attacking the wild guavas on Kauai, especially the wai-awi variety.

A number of fungus diseases occur on the guava, but none are apparently of any serious detriment to the plant. The common sooty mold (*Meliola Camelliae* [Catt.] Sacc.) which infests a wide variety of plants in Hawaii—banyan, fig, avocado, citrus fruits, and others—is exceedingly pestiferous on the guava in many districts. It coats the foliage and young branches with an ugly black incrustation and is obviously an inhibiting factor in photosynthesis, transpiration, and respiration.*

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* *Galesus silvestrii* Kieffer, *Dirhinus giffardii* Silv., and *Opius humilis* Silv.

The guava fruit-rot is caused by *Glomerella Psidii* (G. Del.) Sheldon, and is more or less common in the West Indies, Florida, and California. This fungus is closely related to the most destructive apple disease in the United States, namely the bitter-rot (*G. rufomaculans* [Berk.] Spaulding & Van Sch.).† The guava fruit-rot first appears as brown decaying spots here and there on the rind. These diseased areas are finally covered with masses of salmon-pink spores. As the fungus continues its activity within the fruit, the latter gradually rots, and becomes wrinkled and shrunken. This disease is not prevalent in Hawaii.

2. The Sweet Red Guava

This is a variety of the common yellow guava and has the general characters of the latter. It requires a more humid habitat and is characteristic of the upper valleys, ravines, and higher levels. The flesh is deep pink, and is firm and sweet. This form may be the classical "*pomiferum*" variety.

3. The White Lemon Guava

This is a cultivated variety of *P. Guajava*, and occurs in a number of the island gardens. The shrub usually grows more erect and arborescent in habit than do the others in this group. The fruit is pyriform (the "*pyriferum*" variety of the literature), and often is three inches in length. The skin is rough and greenish white or yellowish in color. The flesh is white, and quite sweet in flavor, with a delicate aroma. This is a choice fruit for eating out of hand, or for serving sliced on the table.

4. The Wai-awi Guava

The so-called "white guava" was introduced into the islands at a very early date and is now abundant. It often occurs far up in the mountains and ravines, surrounded by indigenous vegetation, and giving no hint of its exotic origin. It is quite distinct from the common guava, in habit, foliage, and fruit, and undoubtedly deserves specific, or at least subspecific, rank. It is a graceful, symmetrical, tall shrub or tree, with smooth trunk and branches, and a handsome crown of very dark green, glossy foliage. In favorable situations, where the humidity is sufficient, the wai-awi guava attains a height of 6–12 m., although ordinarily it is 3.5–6 m. The leaves are small, oval, smooth and glossy, and are crowded towards the ends of the branches. The sprays of foliage are of distinct beauty. The flowers are white and very fragrant. The wai-awi guava is a prolific producer of fruit, and bears more or less continuously throughout the year. The fruit is small, 2.5–5 cm. long, ovoid, and thin-skinned. It is rich, clear yellow in color, and the flesh is yellow and juicy. This variety does not form continuous scrub stands, but grows here and there, as isolated individuals or in small clumps. The birds feed eagerly upon its fruits and have carried it into nearly all the valleys.

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* See Webber, H. J. Sooty mold of the orange and its treatment. U. S. Dept. Agr. Div. Phys. & Path. Bull. 13: 1–34. *pl. 1–5.* 1897.

† See Halsted, B. D. Laboratory studies of fruit decays. N. J. Agr. Expt. Sta. Rept. 1892, 326–330.

An interesting feature of the guava in Hawaii is that numerous forms of the endemic and highly precinctive arboreal molluscs (*Achati nellidae*), have migrated onto the guavas. Messrs. J. S. and Oliver Emerson, who have made large collections of the Hawaiian snails, report that *Achatinella phaezona*, *A. fulgens* and its *plumata* pattern, *A. cestus* and *A. rutila*, all occur in the wai-awi guava, in such regions as Ke-awa-awa, Niu, and Wailupe Valleys. On the common guava they have found *A. stewartii* (*adusta* pattern), *A. turgida*, and *Auriculella pulchra*, the latter being exceedingly plentiful. The nomenclature is that of Cooke and Pilsbry.

5. THE GUISARO GUAVA

The *guisaro*, *P. molle* Bertol., is also known as the sour *guisaro*, or *guayaba acida*. It is native to Mexico and Central America but has been introduced into Florida and California. It was introduced into the Hawaiian Islands by Mr. A. Jaeger, and specimens occur in Honolulu gardens. The *guisaro* is a low-growing, slender, straggling shrub or small tree. The young branchlets, peduncles, and lower surfaces of the leaves are reddish velvety. The leaves are oval-oblong, 7.5–12 cm. long, apex apiculate, base obtuse or shortly acute; stiff, chartaceous, light green, rough or puberulent. The peduncles are erect and three-flowered. The flowers are white and fragrant. The fruit is abundant; spherical, 2.5 cm. in diameter; the rind is brownish green, becoming pale yellow when mature. The flesh is white, acid, and inferior in quality and aroma. This species is not recommended for planting, as its fruits lack the rich flavor of *P. Guajava.*

6. The Red Strawberry Guava

This species, *P. Cattleianum* Sabine, is also known as the Chinese guava, or purple guava. It is a native of Brazil and is there called *araça de praya.* It is one of the hardiest species. Within relatively recent years it has been introduced into Florida, California, and Hawaii. Like the others, it is a shrub or small tree, 5–8 m. high. The bark is smooth and greenish brown; the branchlets are glabrous. The leaves are obovate-elliptic, 6–9 cm. long, apex acute, base acute to cuneate; thick and leathery, dark green, and glossy. Like the wai-awi guave, it is in flower and fruit almost continuously throughout the year. The peduncles are axillary and one-flowered; the flowers are white and fragrant. The calyx-tube is turbinate, four- to five-lobed; the lobes are broadly oblong; petals obovate, thin; style slender; stigma peltate; ovary four-locular.

The fruit is spherical or ovate, 2.5–3.5 cm. in diameter; rich dark purplish or claret red when mature. The skin is very thin and tender. The flesh is soft, juicy, and melting in texture; it is reddish next to the skin and white toward the center. The flavor is very fine, acid-sweet, and aromatic, and likened to that of the strawberry. It lacks the pungency of *P. Guajava.* There are many small, hard seeds. The sugar content of the guava is not high. The strawberry guava contains more acid than the other varieties but is less acid to the taste.

Although very satisfactory for jellies and jams, the strawberry guava is too fragile for shipment as fresh fruit. The Hawaii Station* carried on some cold storage experiments, which were summarized as follows:

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*Wilcox, E. V., & Hunn, C. J. Cold storage for tropical fruits. Haw. Agr. Exp. Sta. Press Bull. 47. 1914.

> A few fruits of the strawberry guava (*Psidium cattleianum*) were placed in cold storage in the 32° and 36° F. rooms. This fruit is one of the preferred host plants of the fruit fly, and a part of the fruit used in the experiment was infested. The fruit was picked in a nearly ripe condition. The strawberry guava is not well adapted to cold storage. Practically all of the fruit was shriveled and fermented or decayed within one month in both the 32° and 36° F. rooms. Mildew developed abundantly on the rind and only a few of the fruits kept their normal flavor and appearance more than two weeks.

Analyses of various Hawaiian fruits were made by the Hawaii Agricultural Experiment Station in 1914, and the guavas were reported as follows, the numbers representing percentages:

Name	Edible portion	Total solids	Ash	Total sugars	Fat	Fiber
P. Guajava						
Common.....	84.69	17.78	.531	7.38	.524	4.445
White.......	87.76	18.75	.676	8.26	.412	5.105
Trinidad.....	86.62	15.43	.651	6.34	.353	4.425
P. Cattleianum						
Chinese......	98.01	20.08	.635	10.01	.418	3.868
Common.....	98.60	18.27	.743	4.46	.554	6.146
Common.....	81.16	23.75	.755	5.63	.790	9.378

7. THE YELLOW STRAWBERRY GUAVA

This is *P. Cattleianum* var. *lucidum* Hort., often listed in the trade catalogues as *P. lucidum*, *P. chinense*, and *P. sinense*. It is sometimes called Chinese guava. It is occasionally cultivated in the Hawaiian Islands, but is not common, and does not occur wild. It is a low-growing shrub, with obovate leaves, white flowers, and fruit spherical, 3–3.5 cm. in diameter, and deep sulfur yellow in color. The flesh is sweet, yellow, and more delicately flavored than that of the species.

There are several other species of guava that are of horticultural importance in other parts of the world, but not occurring in the Hawaiian Islands. *P. Friedrichsthalianum* (Berg) Niedenzu, is a well-known Costa Rican species; *P. Araça* Raddi grows on the dry uplands of Brazil; and *P. montanum* Swartz is native to the mountains of Jamaica. The so-called black guava is *Guettarda argentea* Lam., a rubiaceous Jamaican tree, bearing black, globose, fleshy fruits. The "Chilean guava" is a myrtaceous shrub of

Chile (*Myrtus Ugni* Molina), 1–2 m. high, with dark green, shining, ovate leaves, white flowers, and edible, aromatic berries. The "pine-apple guava" of California is *Feijoa Sellowiana* Berg, a South American myrtaceous plant, which resembles the true guavas in growth and fruit.

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